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EXPLORING THE HERBAL TRIFECTA: AMLA REETHA, AND JACKFRUIT IN SHAMPOOS: - A PHARMACOGNOSTICAL AND PHARMACOLOGICAL REVIEW

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ABSTRACT

This review explores the Pharmacognostical and Pharmacological properties of Amla (*Phyllanthus emblica*), Reetha (*Sapindus mukorossi*), and Jackfruit (*Artocarpus heterophyllus*), emphasizing their applications in Shampoos. Amla, rich in vitamin C and antioxidants, is known for its hair-strengthening and scalp-nourishing effects. Reetha, with its natural saponins, offers potent cleansing and antimicrobial properties, making it an effective natural surfactant. Jackfruit, packed with vitamins A and C, and phytonutrients, contributes to hair hydration and overall scalp health. This review synthesizes current research, highlighting the synergistic benefits of these botanicals in enhancing hair care formulations. By integrating traditional knowledge and modern scientific insights, it aims to provide a comprehensive understanding of these herbal ingredients' therapeutic potentials and their roles in promoting hair health, thus supporting their inclusion in natural and effective shampoo products.

1. INTRODUCTION

Integrating traditional botanical ingredients into contemporary formulations is gaining popularity. This method merges ancient herbal wisdom with modern scientific advancements, improving the effectiveness and attractiveness of natural and herbal products to meet the rising consumer demand for holistic health solutions.[1] Amla, reetha, and jackfruit are renowned for their long-standing historical use and substantial pharmacological advantages, such as antioxidant benefits, promotion of hair and skin health, and support for the immune

system. These qualities make them highly valuable in both traditional and contemporary medicinal practices.[2,3] Amla, or Indian gooseberry, is renowned for its rich Vitamin C content and powerful antioxidants. In Ayurveda, it's cherished for promoting hair health, stimulating growth, and preventing premature greying. Its potent properties have been extensively utilized to nourish hair, making it thicker, stronger, and more lustrous. Amla stands as a time-honoured remedy, deeply ingrained in traditional practices for its holistic benefits in hair care.[4] Reetha, also known as soapnut, is cherished for its natural saponin, which provides gentle cleansing properties, making it a mainstay in traditional hair care practices. Its rich lather effectively removes dirt and impurities while maintaining the scalp's natural oils, thus promoting healthy hair. Renowned for centuries, reetha continues to be a preferred choice for those looking for a mild yet effective hair cleansing solution, embodying the gentle touch of nature in beauty routines.[5] Though not as commonly emphasized in haircare, jackfruit provides a distinct blend of nutrients and bioactive compounds with therapeutic benefits. Packed with vitamins, minerals, and antioxidants like vitamin C and beta-carotene, it nourishes the scalp, fortifies hair follicles, and improves hair texture. Furthermore, its antimicrobial properties help prevent scalp infections, while its moisturizing effects alleviate dryness and frizz. Integrating jackfruit into haircare routines can promote healthier, more vibrant hair.[6] This review delves into pharmacological and Pharmacognostical profile of Amla, reetha, and jackfruit, exploring their individual and combined benefit in herbal shampoo formulation. By examining the scientific evidence supporting their efficacy, this review aims to underscore the potential of these botanical in enhancing hair health and providing a natural alternative to synthetic ingredients in personal care product.

2. Pharmacognostical and Therapeutic benefits of amla

2.1 *Emblica officinalis* linn.

Mother nature has given us amazing medicinal plants to help us live a healthy and disease-free life. The most commonly used one is the Indian gooseberry, also known as Amla (*Phyllanthus emblica*), which is a member of the Euphorbiaciae family.[7] The species is indigenous to India and can also be found growing in South East Asia, China, Malaysia, Pakistan, Uzbekistan, Sri Lanka, and other tropical and subtropical areas.[8] It has several different chemical components, including phenols, alkaloids, and tannins, among many others.[9] According to pharmacological research, P. emblica has anti-aging, anti-apoptotic,

anti-inflammatory, hepatoprotective, nephroprotective, anti-viral, cytoprotective, anticancer, anti-jaundice, anti-dyslipidemic, and anti-diabetic properties etc.[10]

2.1.1 Botanical description

2.1.2 Common name for *Emblica officinalis*[11]

Languages	Traditional name
Sanskrit	Dhatri, Adi Phala
Hindi	Amlika, Amla
Punjabi	Ambli
Bengali	Amla, Amlaki
Telegu	Usirikai
Tamil	Nelli
Gujarati	Amabali
Kannada	Amalaka
Marathi	Aola.

2.1.3 Taxonomical classification[12]

Kingdom	Plantae (Plant)
Division	Angiospermae (flowering plant)
Class	Dicotyledonae
Order	Geranial's
Family	Euphorbiaciae
Genus	*Emblica*
Species	Officinalis Geartn.

2.2 Plant morphological description: - 8 to 18 meters tall, this small to medium-sized deciduous tree has thin, light grey bark that peels off in tiny, uneven flakes.

Leaves: - Leaves are simple, subsessile, light green leaves that resemble pinnacles are tightly spaced along the branchlets.

Flowers: - Flowers are greenish yellow, in axillary fascicles, unisexual, with few, subsessile, three-celled ovary females and many males on short, slender pedicels.

Fruits:- Globose, meaty, pale yellow fruits with six oblique vertical grooves surrounding six trigonous seeds in two-seeded, three-seeded crustaceous cocci.[13]

2.3 Phytochemical constituents:- Phytochemicals found in *Emblica Officinalis* fruits include organic acid, vitamin C, triterpenes, alkaloids, flavonoids, carbohydrates, and amino acids etc.[14]

2.4 Geographical distribution: - It grows abundantly in Madhya Pradesh's deciduous forests and is frequently found in tropical and subtropical regions, seacoast areas, hill slopes up to 2000meters, plains, and the heights of Kashmir. It is also found in Burma.[15]

2.5 *Emblica officinalis* Linn. fruit powder Standardization parameter.[16]

Test	Result
Moisture content	25.4%
Ash value	7.5%
Foreign matter	Nil
PH (Water maceration)	3.16%
Foaming index	100
Acid insoluble ash	8%
Water soluble ash2%	2%
Swelling index	7ml

2.6 Pharmacological activity

	Major findings	Reference
1. Antimicrobial activity	Because of its Antibacterial properties, EO has been shown to be effective against Serratia marcescens, Escherichia coli, Proteus mirabilis, Klebsiella Pneumonia etc.	[17]
2. Antioxidant activity	Research showed that Amla preparations included significant amounts of Superoxide dismutase (SOD), a potent Antioxidant that scavenges free radicals.	[18]
3. Antifungal activity	Higher Antifungal activity was demonstrated by the methanol extract of *E. officinalis* against R. solani and F. Oxysporum.	[19]
4. Antidiabetic activity	Amla, a Vitamin C-rich food, assists people with diabetes by increasing the synthesis of insulin and reducing blood sugar. It activates the Langerhans Islets.	[20]
5. Immunomodulatory activity	Fruit extracts from *E. officinalis* have been shown to exhibit strong Immunomodulatory effects.	[21]
6. Ant inflammatory activity	At larger dosages, Amla exhibits anti-inflammatory properties in an animal model by reducing granulomatous tissue and edema.	[22]
7. Anticancer activity	*P. Emblica* fruit extract exhibits potent Anticancer activity against various human cell lines at 50–100 µg/ml concentration.	[23]
8. Antiulcer activity	In studies against Ulcers, EO's methanolic extract had notable effects on ulcer healing and protection**.**	[24]
9. Snake venom neutralizer	The plant extracts of EO considerably reduced the venom of Najakaouthia and Viperarussellii in both in-vitro and in-vivo	[25]

	experiments.	
10. Antiaging property	Promote young skin by inhibiting MMP-1 in human skin cells and increasing procollagen synthesis.	[26]
11. Cardioprotective activity	This cardioprotective activity of *E. officinalis* is believed to be caused by the presence of tannoids, specifically gallic acid, corilagin, emblicanin-A and -B, and ellagic acid.	[27]
12. Antipyretic and Analgesic activity	Ethanolic and aqueous extracts of *Emblica officinalis* fruits (500 mg/kg) demonstrated significant Anti-pyretic effects in rats with brewer's yeast-induced hyperthermia.	[28]
13. Insecticidal activity	*E. officinalis* contains Saponins that have Cytotoxic or Insecticidal effects on some insects.	[29]
14. Osteoporosis prevention	Amla fruit (*Emblica officinalis*) strengthens bones by promoting Osteoclast maturation, aiding bone maintenance and remodelling.	[30]
15. Dermo protective activity	Because of its potent Antioxidant properties, the extract of *E. officinalis* is known to protect human dermal fibroblasts from oxidative stress**.**	[31]
16. Antihyperlipidemic activity	Fruit juice and gallic acid obtained from *P. emblica* were tested for their Hyperlipidaemic potential in a range of experimental animal models, it shows Antihyperlipidemic activity.	[32]
17. Improve eyesight	Amla, the fresh extract from the Indian gooseberry, has been found to support healthy vision and may help treat problems like Glaucoma and Conjunctivitis.	[33]
18. Gout treatment	Consuming a mixture of Amla juice and aged ghee aids in joint softening and contributes to the alleviation of gout symptoms.	[15]
19. Memory enhancing activity	Amla powder demonstrated a correlation between dosage and enhancement in memory scores among both young and aged mice.	[34]
20. Antitussive activity	Researchers confirmed the cough-suppressing effects of EO in attentive cats by mechanically stimulating the mucous areas of the laryngopharynx and tracheobronchial passages in their airways.	[9]

2.7 Benefit of amla in shampo

1. Strengthens hair follicles for healthier, resilient strands.[35]
2. Minimize hair loss.[36]
3. Avoid premature greying of hair.[37]
4. Effectively prevent dandruff.[38]

5. Enhances and softens hair.[39]
6. Increases hair volume.[40]
7. Helps to maintain darken colour of hair.[41]
8. Inhibit the development of fungi.[35]
9. Protect hair from UV radiation.[42]
10. Enhance the texture of hair.[43]

3. Pharmacognostical and Therapeutic benefit of *sapindus mukorossi*

3.1 Sapindus mukorossi

Sapindus mukorossi, commonly referred to as "soapnut" or "aitha," is a member of the Sapindaceae family.[44] It is extensively cultivated in the higher regions of the Indo-Gangetic plains, as well as in the Shivalik and sub-Himalayan regions, at elevations ranging from 200 meters to 1500 meters.[45] *S Mukorossi* is known as one of the primary sources of Saponin also it contains sugars, mucilage, saponins, triterpenoids, fatty acids, flavonoids, and other compounds.[46] It is widely used in Ayurvedic formulations, including Shampoos, cleansers, and medicinal treatments for conditions like eczema, psoriasis, and freckle removal. Additionally, it possesses some Insecticidal properties and has been traditionally employed to eradicate scalp lice.[44]

3.1.1 Botanical distribution

3.1.2 Vernacular names[47]

Sl. No.	Language	Traditional name
1.	Bengali	Ritha
2.	Assamese	Haithaguti
3.	Hindi	Aritha, Kanmar
4.	Punjabi	Thali, Dodan
5.	Sanskrit	Urista, Arista
6.	Telegu	Kunkudu
7.	Kumon	Ritha
8.	United Province	Ritha, Kanmar
9.	Italian	Uriya.

3.1.3 Taxonomical classification[47]

Kingdom	Plantae
Division	Magnoliophyte
Class	Magnoliopsida
Order	Sapindales
Family	Sapindaceae
Genus	Sapindus L

Species	*Sapindus Mukorossi*

3.2 Plant morphological description

Leaves:- The tree is covered with 30 to 50 centimetre-long, alternating, paripinnate leaves, which are made up of five to ten pairs of oppositely oriented, lanceolate leaflets.[48]

Bark: - The bark has a dark-pale yellow colour and a smooth texture. It has several vertical line lenticels and fissures that exfoliate in uneven wood scales.[48]

Flowers: - The flowers are small, measuring approximately 5 mm in diameter. They are located at the end of the stem, and there are many of them. These flowers are greenish-white, mostly bisexual, and appear without stalks, with some being polygamous.[49]

Fruits: -The fruit is a rounded, shiny, tough-skinned drupe that appears yellow and holds one to three small, round, black seeds loosely inside. The colour of the fruit transitions from yellow to orange and eventually dark brown as it matures.[50]

Seeds:- The seeds are spherical, sleek, and dark in colour, with a diameter ranging from 0.8 to 1.3 cm.[50]

3.3 Phytochemical constituents: - The phytochemical screening for ethanol plant extract revealed the presence of tannins, flavonoids, alkaloids, phytosterols, phenolic compounds, and saponins.[51]

3.4 Geographical distribution: - *Sapindus mukorossi*, or the Soap nut tree, is native to the Indian subcontinent, thriving in the Himalayan foothills, and extends its range to China, Japan, and Southeast Asia.[52]

3.5 Standardization parameters of *sapindus mukorossi*[53]

Sl. No.	Parameters	Result
1.	Acid insoluble ash	0.08%
2.	Water soluble ash	0.70%
3.	Total ash	2.35%
4.	Ethanolic extractive value	42.6%
5.	Methanolic extractive value	59.8%
6.	Diethyl ether extractive value	1.1%
7.	Ethyl acetate extractive value	9.3%
8.	Petroleum ether extractive value	0.0%
9.	aqueous extractive value	77.8%

10.	Foaming index	5000
11.	P^H	4.71
12.	Loss on drying	10.74%

3.6 Pharmacological activity

	Major findings	Reference
1. Anti Inflammatory activity	Extracts from the stem and bark of *Sapindus mukorossi* showed anti-inflammatory efficacy in experiments with rats that had their paws swollen due to the effects of carrageenan.	[54]
2. Antipyretic activity	*S. Mukorossi* bark extract lowers rat fever induced by Saccharomyces cerevisiae injection, suggesting pain and temperature reduction potential.	[55]
3. Wound healing activity	The use of *S. mukorossi* seed oil on skin wounds in rats sped up the healing process compared to untreated rats.	[56]
4. Contraceptive	The saponins extracted from *S. mukorossi* have shown sperm-killing effects in laboratory experiments.	[57]
5. Hepatoprotective activity	The ethanol extract of *S. mukorossi* exhibited promising effects in reducing the levels of various enzymes associated with liver damage, including alanine transaminase, aspartate transaminase etc.	[58]
6. Anticancer activity	An extract from the leaves and stems of *S. mukorossi*, abundant in polysaccharides, effectively suppressed the growth and reproduction of A549 human Adenocarcinoma cells.	[59]
7. Mullocicidal activity	The pericarp extract and various saponins found in *S. Mukorossi* have demonstrated the ability to effectively control golden apple snails (Pomacea canaliculata), which are a significant threat to rice crops.	[60]
8. Insecticidal activity	The methanol extract from both the leaves and stems of *S. mukorossi* plants demonstrates potential as a bio-control agent against the Grapholita molesta insect.	[61]
9. Antiplatelet activity	The ethanolic extract from the galls of *S. mukorossi* contained two saponins, Sapindus saponins Q and R, which exhibited stronger anti-platelet aggregation effects compared to aspirin.	[60]
10. Antimicrobial activity	Both ethanol and chloroform extracts from *Sapindus mukorossi* effectively inhibited Helicobacter pylori growth in male rats after oral administration for seven days.	[62]
11. Antitrichonomas activity.	The combination of saponins from the *Sapindus mukorossi* plant is ten times more effective at combating Trichomonas, requiring only 0.005% concentration, compared to its effectiveness against human sperm, which requires 0.05% concentration to be effective.	[63]
12. Cytotoxic activity	Triterpenoid saponins from *Sapindus mukorossi*, including α-hederin, β-hederin, and others, demonstrated significant cytotoxicity (10-100µg/ml) against various cell lines, surpassing the reference compound	[64]

	Strychnopentamine.	
13. Antioxidant activity	It shows antioxidant property by increasing DPPH scavenging.	[65]
14. Anti asthmatic activity	At concentrations of 380 mcg/ml and 640 mcg/ml, *S.Mukorossi* exhibited significant inhibition of acetylcholine-induced bronchoconstriction in isolated goat trachea, demonstrating its potential as an Anti-Asthmatic agent.	66]
15. Antidiabetic activity	The root extract of *Sapindus Mukorossi*, when administered in doses of 250 and 500 mg/kg, led to a noteworthy decrease in serum glucose levels in rats with diabetes.	[67]
16. Anxiolytic activity	Methanolic extract of *Sapindus Mukorossi* [200 mg/kg &400 mg /kg] showed significant anxiolytic activity in Mice.	[68]
17. Antihypertensive activity	Alcohol extracts from *S. mukorossi* effectively manage blood lipid levels and help prevent hypertension in a rat model.	[69]
18. Gonorrhoea treatment	The saponin extract from *S. Mukorossi* showed inhibitory effects on the growth of N. gonorrhoeae at concentrations of 1000 micrograms per millilitre.	[70]
19. DpSc regeneration	*S. mukorossi* seed oil boosts the ability of DPSCs to differentiate into bone and tooth tissues by upregulating their ALP gene expression.	[71]
20. Antibacterial activity	*S. Mukorossi* shows antibacterial effects against the gram-positive bacteria Bacillus subtilis and Micrococcus luteus.	[72]

3.7 Benefit of *sapindus mukorossi in* shampoo

1. Assists in regulating Sebum secretion by minimizing the overproduction of oil.[73]
2. The presence of *Sapindus mukorossi* in shampoo effectively combats dandruff through its inherent cleansing and antibacterial attributes.[74]
3. Eliminating lice while simultaneously promoting Scalp Wound healing[75] [Kalyani Barve].
4. It shows good foaming property in Shampoo.[76]
5. Eco friendly and Bio degradable.[77]
6. *Sapindus mukorossi* in Shampoo acts as a germicide, killing bacteria, and a deodorant, neutralizing odours, naturally.[78]
7. Acts as hair tonic in shampoo.[79]
8. Demonstrates a cooling sensation and guards against scalp dehydration.[35]
9. It have gentle cleansing property.[80]
10. Prevent hair loss.[81]

4. Pharmacognostical and Therapeutic benefit of *artocarpus heterophyllus Lam.*

4.1 *Artocarpus heterophyllus*

The Jackfruit, scientifically named *Artocarpus heterophyllus Lam.*, is a tropical fruit that undergoes ripening through a process called climacteric. It belongs to the Moraceae family and is indigenous to the Western Ghats of India. It's widely found across Asia, Africa, and certain parts of South America.[82] Therefore, jackfruit is extensively distributed throughout India. It is recognized as the largest fruit borne by a tree worldwide (FAO 2012), and India is considered its homeland. For centuries, jackfruits have held a prominent place in Indian agriculture and culture.[83] The various components of the jackfruit tree, such as its fruits, leaves, and bark, have long been utilized in traditional medicine for their potential anticarcinogenic, antimicrobial, antifungal, anti-inflammatory, wound-healing, and Hypoglycemic properties, among others.[83]

4.1.1 Botanical distribution

4.1.2 Vernacular name[84]

Sl. No.	Language	Traditional name
1.	Bengali	Kanthal
2.	Hindi	Panas
3.	Sanskrit	Kantaphal
4.	Tamil	Palaa
5.	Kannada	Halasu
6.	Marathi	Phanas
7.	Malayalam	Chakka

4.1.3 Taxonomical classification[85]

Kingdom	Plantae
Phyllum	Tracheobionta
Division	Magnaliophyta
Class	Magnaliopsid
Order	Urticales
Family	Moraceae
Genus	Artocarpus
Species	*Artocarpus heterophyllus* Lam

4.2 Plant morphological description

Jackfruit trees are medium-sized evergreens, typically reaching heights of 8–25 meters with stem diameters of 30–80 centimetres. Their canopy starts conical or pyramidal in youth but spreads into a domed shape as they mature, casting dense shade. They feature heavy side branching from near the ground and exude sticky white latex from all parts when injured.[86]

Flowers: - The blossoms are small and start off a light green hue, which deepens as they mature. Female flowers are notably larger and either elliptical or rounded, featuring a tubular calyx. Pollination is said to occur through both insects and wind, resulting in a significant amount of cross-pollination.[86]

Leaves: - The leaves display a dark green colour and grow alternately on the stem. They are smooth-edged, simple, shiny, and tough, with a leathery texture and a stiff structure. Typically, large at around 16 cm in length, they are elliptical to oval in shape, maintaining uniformity. During their early growth stages, the leaves may have lobes, especially on young shoots.[87]

Seeds: - The seeds are a light brown colour, with a rounded shape measuring 2-3 cm in length and 1-1.5 cm in diameter. They are surrounded by a thin whitish membrane, with up to 500 seeds typically found in each fruit.[87]

Fruit: - The jackfruit's fruit consists of a compound or multiple fruits encased in a tough, green to yellow-brown outer skin. This skin is made up of hexagonal, bluntly conical sections that cover a thick, rubbery, whitish to yellowish inner wall. The sizable and differently shaped fruits measure between 30 to 100 cm in length and 15 to 50 cm in diameter. They can weigh anywhere from 10 to 25 kg (22 to 55 pounds) or even more.[88]

4.3 Phytochemical composition: - The fruit contains a variety of plant compounds like flavonoids and stilbenoids, including morin, artocarpin, dihydromorin, cynomacurin, isoartocarpin, cyloartocarpin, artocarpesin, artocarpetin, artocarpanone, oxydihydroartocarpesin, norartarpetin, and cycloartinone.[89]

4.4 Geographical distribution: - It is widely spread across various warm and humid regions, notably in Asia, Africa, and South America. Presently, it holds significant agricultural importance in countries such as India, Burma, China, Sri Lanka, Malaysia, Indonesia, Thailand, and the Philippines.[90]

4.5 Standardization parameter of *artocarpus heterophyllus lam.*[91]

Sl. No.	Parameter	Result
1.	Moisture content	82.88%
2.	Ash value	0.98%
3.	P^H	6.29
4.	Dry matter	17.12%
5.	Fibre	0.55%

4.6 Pharmacological activity

	Major findings	Reference
1. Antiviral properties	It has been discovered that *A. heterophyllus's* jackfruit lectin (JFL) has cytopathic activity and in vitro inhibitory action against Varicella zoster virus (VZS), CMV, and Herpes simplex virus type HSV-2.	[92]
2. Anti Inflammatory	The extract from jackfruit seeds showed the ability to suppress inflammation in RAW 264.7 cells when administered at a concentration of 30 μg mL−1.	[93]
3. Anti-cancer property	Jackfruit contains compounds like Saponin, Isoflavones, and lignans, which have chemoprotective properties. These substances can inhibit the mutagenicity of AFB1 (aflatoxin B1) and the growth of Cancer cells.	[94]
4. Antioxidant property.	The Antioxidant effects of fresh jackfruit seed and flesh are notable due to their high content of ascorbic acid equivalents and Gallic acid. Gallic acid contributes to about 70% of the total Antioxidant activity.	[95]
5. Antidiabetic activity	Samples from *Artocarpus heterophyllus* notably enhanced the ability to tolerate glucose in both healthy individuals and those with diabetes when tested at oral doses equal to 20 grams per kilogram of the initial substance.	[96]
6. Melanin biosynthesis prevention	The extract from jackfruit wood and the phytochemical artocarpanone showed effectiveness in inhibiting both Mushroom tyrosinase activity and Melanin production in B16 Melanoma cells.	[97]
7. Anti Osteoporotic activity	Flavonoids extracted from *A. heterophyllus* have been discovered to possess IC50 values spanning from 1.4 to 93.9 μm. These compounds are recognized for their ability to decrease Cat-K activity.	[98]
8. Immunomodulatory effect	Jacalin, the primary protein derived from seeds, has been discovered to be useful in several areas, including the isolation of human plasma glycoproteins, the study of IgA-nephropathy, analysis of O-linked glycoproteins, and the detection of tumours.	[99]
9. Anticariogenic activity	The Methanolic extract from the leaves has demonstrated noteworthy ability to inhibit primary cariogenic bacteria. Through bioactivity-guided fractionation, it was found that this inhibition is primarily mediated by two compounds, artocarpin and artocarpesin.	[100]
10. Anthelmintic	Jackfruit decoctions exhibited significant efficacy	[101]

activity	in eradicating nematode larvae at high concentrations. The effective dose for 50% eradication (ED50) was observed at a concentration of 40% for the decoction. These findings imply that decoctions derived from jackfruit and its leaves could serve as effective anthelmintics for goats.	
11. Antimalarial activity	Flavonoids like Artonin and artocapones exhibit anti-malarial properties, effectively combating the malaria parasite's growth.	[102]
12. Wound healing activity	*A. heterophyllus* shows promise in wound healing based on studies using porcine skin wounds. The healing effects of its leaf extract (EAAH) are linked to phenolic compounds like flavonoids and triterpenoids, notably ursolic acid. These substances help in wound contraction, promote epithelialization, and have antimicrobial properties.	[103]
13. Haematinic properties	Ethanol leaf extract of (*Artocarpus heterophyllus*) has hematinic properties due to its iron content, aiding in blood production and preventing Anaemia.	[104]
14. Anti-Ulcer activity	The hydroalcoholic extract from *Artocarpus heterophyllus* lam fruits demonstrates a preventative effect against ulcers in albino Wistar rats. This was observed through administering doses of 200 mg/kg and 400 mg/kg.	[105]
15. Antihyperlipidemic activity	An ethanol extract of *Artocarpus heterophyllus* at a dosage of 100 mg/kg body weight exhibited antihyperlipidemic effects in albino rats, reducing both cholesterol and triglyceride levels.	[106]
16. Antifungal activity.	The chitin-binding lectin found in seeds, known as jackin, has been demonstrated to hinder the development of Fusarium moniliforme and Saccharomyces cerevisiae.	[107]
17. Antibacterial activity	The butanol extracted *A. heterophyllus* root bark and fruits demonstrated the highest activity against Bacillus cereus, B. coagulants, B. megaterium, and B. subtilis.	[108]
18. Antidiarrheal activity	Jackfruit may possess antidiarrheal properties due to its fibre content and potential tannin presence, aiding bowel regularity.	[109]
19. Hepatoprotective.	Jackfruit exhibits hepatoprotective activity due to its antioxidants, flavonoids, and phytochemicals, aiding liver health and function.	[110]
20. Fibrinogenolytic activity	Jackfruit exhibits fibrinogenolytic activity by breaking down fibrinogen into soluble fragments, aiding in blood clot prevention.	[111]

4.7 *Artocarpus heterophyllus* benefit in shampoo

1. Jackfruit seed extract in shampoo provides antifungal benefits, and promoting a healthier scalp.[112]
2. Jackfruit can help bring back the natural shine and radiance of hair.[113]
3. Jackfruit seeds are rich in saponins, which function as a natural cleanser in shampoos.[114]
4. Jackfruit seed extract in shampoo can offer anti-inflammatory effects, helping to soothe scalp irritation.[115]
5. Incorporating jackfruit seed into shampoo tightens scalp skin, reducing oiliness for a healthier scalp.[116]
6. Jackfruit seeds contain vitamin A, which facilitates hair growth.[117]
7. The moisturizing characteristics of jackfruit can aid in preventing and minimizing dandruff by ensuring adequate hydration of the scalp.[118]
8. The nutrients found in jackfruit, like magnesium and potassium, can enhance the resilience of hair, diminishing the occurrence of breakage and split ends.[119]
9. Jackfruit seeds assist in maintaining a balanced pH level on the scalp.[120]
10. Jackfruit seeds can help prevent premature greying of hair due to their antioxidant properties.[121]

DISCUSSION

The Inclusion of traditional botanical ingredients like amla, reetha, and jackfruit in modern formulations signifies a growing trend towards holistic health solutions that blend ancient knowledge with contemporary science. Amla, renowned for its abundant Vitamin C content and antioxidant properties, has long been esteemed in Ayurveda for its wide-ranging benefits in promoting hair health, preventing premature greying, and boosting hair strength and shine. Reetha, with its natural saponins, provides gentle yet effective cleansing, making it a staple in traditional hair care practices. Although jackfruit is less commonly used in traditional hair care, it offers a unique combination of nutrients and bioactive compounds that nourish the scalp, strengthen hair follicles, and enhance hair texture. Scientific research supports the pharmacological benefits of these botanicals, highlighting their potential to improve hair health and provide natural alternatives to synthetic ingredients in personal care products. The combination of traditional botanical knowledge and modern scientific validation underscores the effectiveness and appeal of these natural ingredients, meeting the growing consumer demand for sustainable and health-conscious beauty solutions.

REFERENCES

1. Butler MS. Natural products to drugs: Natural product-derived compounds in clinical trials. Nat Prod Rep, 2008; 25(3): 475–516.
2. Gul M, Liu ZW, Iahtisham-Ul-haq, Rabail R, Faheem F, Walayat N, et al. Functional and Nutraceutical Significance of Amla (Phyllanthus emblica L.): A Review. Antioxidants, 2022; 11(5): 1–15.
3. Afotey B, Emmanuel Yuorkuu, Simon Akinie, Fredrick Eshun, Mohammed Sufyan. Determination of health and nutritional benefits of jackfruits (artocarpus heterophyllus). J Ghana Inst Eng, 2024; 24(1): 33–40.
4. Gaire BP, Subedi L. Phytochemistry, pharmacology and medicinal properties of Phyllanthus emblica Linn. Chin J Integr Med, 2014.
5. Mainkar AR, Jolly CI. Formulation of natural shampoos. Int J Cosmet Sci, 2001; 23(1): 59–62.
6. Adan AA, Ojwang RA, Muge EK, Mwanza BK, Nyaboga EN. Phytochemical composition and essential mineral profile, antioxidant and antimicrobial potential of unutilized parts of jackfruit. Food Res, 2020; 4(4): 1125–34.
7. Raju CA, Begum SS, Kalpana B, Sathish A. Processing and Nutritional Evaluation of Amla (Phyllanthus emblica) Pomace. Asian J Dairy Food Res, 2023; (Of): 1–6.
8. Talreja S, Kumari S, Srivastava P, Pandey S. A complete pharmacognostic review on amla. World J Pharm Pharm Sci, 2021; 8(4): 622–37.
9. Jain PK, Das D, Pandey N, Jain P. Traditional Indian herb Emblica officinalis and its medical importance. Int J ayurvedic Sci, 2016; 4(4): 1–15.
10. Prananda AT, Dalimunthe A, Harahap U, Simanjuntak Y, Peronika E, Karosekali NE, et al. Phyllanthus emblica: a comprehensive review of its phytochemical composition and pharmacological properties. Front Pharmacol, 2023; 14(October): 1–20.
11. Devidas DC, Pramod CS. Phytochemical and pharmacological profile of Emblica officinalis Linn. J Med Pharm Allied Sci, 2021; 10(2): 2698–703.
12. Kalamkar AA, Lal PI, Chaudhary PH, Ruikar DB. A review on Emblica officinalis gaertn. Int J Pharmacogn Pharm Sci, 2023; 5(1): 111–7.
13. Garg N, Meena A, Nain J. Evaluation of physicochemical and preliminary phytochemical studies on the root of Bombax ceiba Linn. Int J Res Ayurveda Pharm, 2011; 2(3): 924–6.
14. Acharya CK, Khan NS, Madhu NR. MEDICINAL USES OF AMLA, Phyllanthus emblica L. (GAERTN.): A PROSPECTIVE REVIEW. Mukt Shabd J, 2021; 10(10): 296–310.

15. Kulkarni KV, Ghurghure SM. Indian gooseberry (Emblica officinalis): Complete pharmacognosy review. Int J Chem Stud, 2018; 2(2): 5–11.
16. Alagar RM, Sushma K, Banji D, Rao KNV, Selvakumar D. Evaluation of standardisation parameters, pharmacognostic study, preliminary phytochemical screening and in vitro antidiabetic activity of Coccinia indica fruits as per WHO guidelines. Indian J Pharm Biol Res, 2014; 2(03): 54–64.
17. Ikram A, Khalid W, Aziz M, Adnan Arif M, Prakash Jha R, Zubair Khalid M, et al. Nutritional and Biochemical Composition of Amla (Emblica officinalis) and its Therapeutic Impact: A Review. Acta Sci Nutr Heal, 2021; 5(2): 153–60.
18. Shinde AM. Medicinal Plant : Amla, 2022; 7(6): 1152–7.
19. Chugh CA, Bharti D. Chemical characterization of antifungal constituents of Emblica officinalis. Allelopath J, 2014; 34(1): 155–78.
20. Sadhana Singh VVRY and BS. Pharmacognostical study of Amalaki (Emblica officinalis Gaertn.). J Pharmacogn Phytochem, 2018. (August).
21. Bhat Scholar PM, Professor A, Umale Professor H, Lahankar Professor M, Pravin Bhat Scholar CM, Bhat PM, et al. Amalaki: A review on functional and pharmacological properties. J Pharmacogn Phytochem, 2019; 8(3): 4378–82.
22. Lanka S. a Review on Pharmacological, Medicinal and Ethnobotanical Important Plant: Phyllanthus Emblica Linn. (Syn. Emblica Officinalis). World J Pharm Res, 2018; 7(04): 380–96.
23. Singh E, Sharma S, Pareek A, Dwivedi J, Yadav S, Sharma S. Phytochemistry, traditional uses and cancer chemopreventive activity of Amla (Phyllanthus emblica): The Sustainer. J Appl Pharm Sci, 2012; 2(1): 176–83.
24. Khan KH. Roles of Emblica officinalis in Medicine - A Review, 2009; 2(4): 218–28.
25. Diwan, Diwan, G., Sinha, K., Lal, N., & Rangare, N. R. Tradition and medicinal value of Indian gooseberry : A review. Journal of Pharmacognosy and Phytochemistry, 2018; 7(1): 2326–2333.
26. Garima, Sinha K, Lal N, Rangare NR. Tradition and medicinal value of Indian gooseberry : A review. J Pharmacogn Phytochem, 2018; 7(1): 2326–33.
27. Dasaroju S, Gottumukkala KM. Review Article Current Trends in the Research of. IntJPharaSciRevRes, 2014; 24(2): 150–9.
28. Shrivastava S, Kaur J, Mehraj M, Feroz F, Chawla J, Kumari S. The Pharma Innovation Journal, 2022; 11(6): 06-16 Emblica officinalis (Amla): A comprehensive review of the miracle berry. Pharma Innov J [Internet], 2022; 11(6): 6–16. Available from:

www.thepharmajournal.com

29. Khosla S, Sharma S. A short description on pharmacogenetic properties of <i> Emblica officinalis</i> Spat DD - Peer Rev J Complement Med Drug Discov, 2012; 2(3): 187.
30. Hasan MR, Islam MN, Islam MR. Phytochemistry, pharmacological activities and traditional uses of Emblica officinalis: A review. Int Curr Pharm J, 2016; 5(2): 14–21.
31. Hassan SM, Mughal SS, Aslam A, Mushtaq M, Munir M, Pervez S, et al. Emblica Officinalis (Amla): A Prospective Review On Distinctive Properties And Therapeutic Applications Of Amla Syeda. Biomed Nurs [Internet], 2020; 6(2): 22–30. Available from: http://www.sciencepub.net/nurse/bnj060220/03_36245bnj060220_22_30.pdf%0Ahttps://www.researchgate.net/publication/342589360_Emblica_Officinalis_Amla_A_Prospective_Review_On_Distinctive_Properties_And_Therapeutic_Applications_Of_Amla%0Ahttps://innovareacade
32. Bhandari P, Kamdod M. Emblica officinalis (Amla): A review of potential therapeutic applications. Int J Green Pharm, 2012; 6(4): 257–69.
33. Grover M. A comprehensive review on Pharmacological and Ayurvedic aspect of Phyllanthus emblica (Amalki). Adv Pharm J, 2021; 6(3): 87–94.
34. Bhide MM, Nitave AS. Roles of Emblica Officinalis (Amla) in Medicine. World J Pharm Pharm Sci, 2014; 3(6): 604–15.
35. Mandal A. a Review on Phytochemical, Pharmacological and Potential Therapeutic Uses of Phyllanthus Emblica. World J Pharm Res, 2017; 6(7): 817–30.
36. Vijayalakshmi A, Sangeetha S, Ranjith N. Formulation and evaluation of herbal shampoo. Asian J Pharm Clin Res, 2018; 11(Special Issue 4): 121–4.
37. Rajlaxmi Deolekar, Toufik Mulani, Bilal Sufi. Review on Formulation and Evaluation of Herbal Hand Wash. Int J Adv Res Sci Commun Technol, 2023; (3): 321–4.
38. Vineetha K, Vindhya VS, Vishranth MB, Yashasvi, Shyam SS, Shabaraya AR. Herbal Shampoo : Benefits , Preparation and Evaluation. J Xi'an Shiyou Univ, 2017; 17(09).
39. Ghadage A, Jain S. Cosmetic Science (Preparation & Evaluation of Herbal Amla Shampoo, 2023; 11(6): 398–415.
40. Arote Rushikesh T, Prof. Bhalekar Sachin M. Preparation and Evaluation of Herbal Anti Dandruff Shampoo. Int J Adv Res Sci Commun Technol, 2022; 2(1): 513–28.
41. Priya JS, Nagapallavi B, Usharani B, Simhachalam B, Srikanthreddy Y. Biosynthesis And New Technique For The Formulation Of Hair Growth Shampoo. J Posit Sch Psychol [Internet], 2022; 6(6): 8287–95. Available from: http://journalppw.com

42. - PRB, - VPK, - KVG, - ANK, - PRK. A Review on Herbal Shampoo and Its Evaluation. Int J Multidiscip Res, 2023; 5(6): 1–13.
43. Sang SH, Akowuah GA, Liew K Bin, Lee SK, Keng JW, Lee SK, et al. Natural alternatives from your garden for hair care: Revisiting the benefits of tropical herbs. Heliyon [Internet], 2023; 9(11): e21876. Available from: https://doi.org/10.1016/j.heliyon.2023.e21876
44. Mokle BA. HERBAL ANTI-DANDRUFF SHAMPOO, 2023.(January).
45. Anjali; Saini, Rita; Juyal D. Sapindus mukorossi: A review article. Pharma Innov J [Internet], 2018; 7(5): 470–2. Available from: www.motherherbs.com/sapindus_mukorossi_extrac
46. Singh S, Ali M. Choloque, 2019; 8(12): 88–96.
47. Kaur M, Handa S. Issue:3 Citation: Manbir Kaur et al. Ijppr. Human [Internet], 2015; 3(3): 173–82. Available from: www.ijppr.humanjournals.comwww.ijppr.humanjournals.com
48. Suhagia BN, Rathod IS, Sindhu S. Sapindus Mukorossi (Areetha): an Overview. Rev Artic Receiv [Internet], 2011; 2(8): 1905–13. Available from: www.ijpsr.com
49. Sochacki M, Vogt O. Triterpenoid Saponins from Washnut (Sapindus mukorossi Gaertn.)—A Source of Natural Surfactants and Other Active Components. Plants, 2022; 11(18): 1–24.
50. Upadhyay A, Singh DK. Efeitos farmacológicos do sapindus mukorossi. Rev Inst Med Trop Sao Paulo, 2012; 54(5): 273–80.
51. Limje DL, Patel JI. SAPINDUS MUKOROSSI : A COMPLETE REVIEW ON PHARMACOLOGY, PHYTOCHEMISTRY AND TOXICOLOGICAL DATA, 2023; 12(1): 83–106.
52. George B, Shanmugam S. Phytochemical screening and antimicrobial activity of fruit extract of Sapindus mukorossi. IntJCurrMicrobiolAppSci [Internet], 2014; 3(10): 604–11. Available from: http://www.ijcmas.com
53. Mahar KS, Rana TS, Ranade SA. Molecular analyses of genetic variability in soap nut (Sapindus mukorossi Gaertn.). Ind Crops Prod, 2011; 34(1): 1111–8.
54. Godar K, Rai SK. Freshwater Green Algae from Raja-Rani Wetland, Bhogateni-Letang, Morang, Nepal. J Plant Resour, 2018; 16(1): 1–16.
55. Ota M. NII-Electronic Library Service. Chem Pharm Bull [Internet], 1970; (43): 2091. Available from: http://www.mendeley.com/research/geology-volcanic-history-eruptive-style-yakedake-volcano-group-central-japan/

56. Shah M, Parveen Z, Khan MR. Evaluation of antioxidant, anti-inflammatory, analgesic and antipyretic activities of the stem bark of Sapindus mukorossi. BMC Complement Altern Med, 2017; 17(1): 1–16.
57. Chen CC, Nien CJ, Chen LG, Huang KY, Chang WJ, Huang HM. Effects of sapindus mukorossi seed oil on skin wound healing: In vivo and in vitro testing. Int J Mol Sci, 2019; 20(10): 1–15.
58. Dhar JD, Bajpai VK, Setty BS, Kamboj VP. Morphological changes in human spermatozoa as examined under scanning electron microscope after in vitro exposure to saponins isolated from sapindus mukorossi. Contraception, 1989; 39(5): 563–8.
59. Peng Q, Zhang Q, Xiao W, Shao M, Fan Q, Zhang H, et al. Protective effects of Sapindus mukorossi Gaertn against fatty liver disease induced by high fat diet in rats. Biochem Biophys Res Commun, 2014; 450(1): 685–91.
60. Liu M, Chen YL, Kuo YH, Lu MK, Liao CC. Aqueous extract of Sapindus mukorossi induced cell death of A549 cells and exhibited antitumor property in vivo. Sci Rep [Internet], 2018; 8(1): 1–15. Available from: http://dx.doi.org/10.1038/s41598-018-23096-w
61. Huang HC, Tsai WJ, Liaw CC, Wu SH, Wu YC, Kou YH. Anti-platelet aggregation triterpene saponins from the galls of Sapindus mukorossi. Chem Pharm Bull, 2007; 55(9): 1412–5.
62. Rahman SS, Begum SA, Mizanur M, Khan R. Investigation of Sapindus Mukorossi Extracts for Repellency, Insecticidal Activity and Plant Growth Regulatory Effect. J Appl Sci, 2007; 3(2): 95–101.
63. Ibrahim M, Khan AA, Tiwari SK, Habeeb MA, Khaja MN, Habibullah CM. Antimicrobial activity of Sapindus mukorossi and Rheum emodi extracts against pylori: In vitro and in vivo studies. World J Gastroenterol, 2006; 12(44): 7136–42.
64. Tiwari P, Singh D, Singh MM. Anti- Trichomonas activity of Sapindus saponins, a candidate for development as microbicidal contraceptive. J Antimicrob Chemother, 2008; 62(3): 526–34.
65. Sağlık I, Güçlüer Ö, Özhakc B. Investigation of the antimicrobial effects of Sapindus mukorossi on endodontic pathogens. J Exp Clin Med, 2020; 37(4): 111–8.
66. Kora AJ. Antibacterial and antioxidant activities of aqueous extract of soapnuts (Sapindus mukorossi). Curr Trends Biotechnol Pharm, 2021; 14(4): 388–95.
67. Goyal S. Medicinal Plants of the Genus Sapindus (Sapindaceae) - a Review of Their Botany, Phytochemistry, Biological Activity and Traditional Uses. J Drug Deliv Ther,

2014; 4(5): 7–20.

68. Of I, Effect N, Sapindus OF, Pain N, In P. Investigation of Neuroprotective Effect of Sapindus Mukroossi Extract on Type1 Diabete Induced Neuropathic Pain Perception in Rat. Int J Pharm Res Technol, 2019; 9(1): 1671–91.
69. Chakraborty A, Amudha P, Geetha M, Surjit Singh N. Evaluation of anxiolytic activity of methanolic extract of Sapindus mukorossi Gaertn. In mice. Int J Pharma Bio Sci, 2010; 1(3).
70. Xu Y, Gao Y, Chen Z, Zhao G, Liu J, Wang X, et al. Metabolomics analysis of the soapberry (Sapindus mukorossi Gaertn.) pericarp during fruit development and ripening based on UHPLC-HRMS. Sci Rep [Internet], 2021; 11(1): 1–11. Available from: https://doi.org/10.1038/s41598-021-91143-0
71. S ELP, H KAS, Divya N, K RVR, Manavalan R, June A. Research Journal of Pharmaceutical , Biological and Chemical Sciences Evaluation of In-vitro antioxidant activity of leaf extract of Andrographis paniculata. Rjpbcs, 2011; 2(2): 891–5.
72. Shiu ST, Lew WZ, Lee SY, Feng SW, Huang HM. Effects of sapindus mukorossi seed oil on proliferation, osteogenetic/odontogenetic differentiation and matrix vesicle secretion of human dental pulp mesenchymal stem cells. Materials (Basel), 2020; 13(18).
73. Dinda G, Halder D, Mitra A, Pal N, Vázquez-Vázquez C, López-Quintela MA. Study of the antibacterial and catalytic activity of silver colloids synthesized using the fruit of: Sapindus mukorossi. New J Chem, 2017; 41(19): 10703–11.
74. Wan K, Ma L, Chen D, Li Z, Zouboulis CC, Chang K, et al. Preparation and decolorization of sapindus mukurossi extract and its application in sebum-control shampoos. J Dermatologic Sci Cosmet Technol [Internet], 2024; 1(2): 100006. Available from: https://doi.org/10.1016/j.jdsct.2024.100006
75. Shweta Patel, Ajay Gupta, Meenakshi Gupta. Formulation and Evaluation of Polyherbal Anti-Dandruff Shampoo and its Marketed Comparison. J Res Appl Sci Biotechnol, 2022; 1(2): 1–9.
76. Barve K, Dighe A. SPRINGER BRIEFS IN MOLECULAR SCIENCE GREEN CHEMISTRY FOR SUSTAINABILITY The Chemistry and Applications of Sustainable Natural Hair Products [Internet], 2016; 8: 45. Available from: http://www.springer.com/series/10045
77. Chen YF, Yang CH, Chang MS, Ciou YP, Huang YC. Foam properties and detergent abilities of the saponins from Camellia oleifera. Int J Mol Sci, 2010; 11(11): 4417–25.
78. Rai S, Acharya-Siwakoti E, Kafle A, Devkota HP, Bhattarai A. Plant-Derived Saponins:

A Review of Their Surfactant Properties and Applications. Sci, 2021; 3(4): 1–19.

79. Bhaskar K. Potential soap, shampoo and detergent plant resources of India and their associated traditional knowledge. Plant Arch, 2018; 18(1): 301–19.
80. Bagade MJ, Ambre SP, Arote CY, Barve CS, Bhavar AR, Shinde MPS, et al. An overview on Herbal Shampoo Formulation And Development. Int Res J Mod Eng Technol Sci, 2023; (12): 251–7.
81. Surve Rashmi, Shivathaya Neha, Sawant Reshma, Bhat Madhura, Yashwant Devraj, Mane Vishal, et al. The Effect of Surfactant on Polyherbal Liquid Shampoo and its Comparative Analysis. Int J Ayurveda Pharma Res, 2022; 10(3): 26–34.
82. Hair K. A Review on Polyherbal Shampoo Powder, 2021; (2).
83. Ranasinghe RASN, Maduwanthi SDT, Marapana RAUJ. 4_Nutritional and Health Benefits of Jackfruit (Artocarpus. Int J Food Sci, 2019; 2019.
84. Rana SS, Pradhan RC, Mishra S. Variation in properties of tender jackfruit during different stages of maturity. J Food Sci Technol [Internet], 2018; 55(6): 2122–9. Available from: https://doi.org/10.1007/s13197-018-3127-9
85. Baliga MS, Shivashankara AR, Haniadka R, Dsouza J, Bhat HP. Phytochemistry, nutritional and pharmacological properties of Artocarpus heterophyllus Lam (jackfruit): A review. Food Res Int, 2011; 44(7): 1800–11.
86. Lyngkhoi MM, Bhattacharjee A, Hegde DK. Detailed Review on Pharmacological Profile of Artocarpus heterophyllus. Int J Pharm Sci Rev Res, 2021; 67(26): 160–4.
87. Prakash O, Kumar R, Mishra A, Gupta R. Review Article Artocarpus heterophyllus (Jackfruit): An Overview. PHCOG REV Rev Artic, 2009; 3(6): 353–8.
88. Artocarpus heterophyllus Lamarck. Artocarpus heterophyllus Lamarck. Edible Med Non-Medicinal Plants, 2012; 3(April): 318–36.
89. Amir M, Khan A, Mujeeb M, Ahmad MA, Siddiqui NA. Phytochemical screening and in vitro antioxidant activity of jawarish amla- A poly herbal formulation. Pharmacogn J [Internet], 2011; 3(26): 54–60. Available from: http://dx.doi.org/10.5530/pj.2011.26.10
90. Sreeja Devi PS, Kumar NS, Sabu KK. Phytochemical profiling and antioxidant activities of different parts of Artocarpus heterophyllus Lam. (Moraceae): A review on current status of knowledge. Futur J Pharm Sci, 2021; 7(1).
91. Srivastava R, Singh A. Jackfruit (Artocarpus heterophyllus Lam) Biggest Fruit with High Nutritional and Pharmacological Values: A Review. Int J Curr Microbiol Appl Sci, 2020; 9(8): 764–74.
92. Goswami C, Hossain MA, Kader HA, Islam R. Assessment of Physicochemical

Properties of Jackfruits' (Artocarpus heterophyllus Lam) Pulps. For Biotechnol, 2011; 15(3): 26–31.

93. Favero J, Corbeau P, Nicolas M, Benkirane M, Travé G, Dixon JFP, et al. Inhibition of human immunodeficiency virus infection by the lectin jacalin and by a derived peptide showing a sequence similarity with gp120. Eur J Immunol, 1993; 23(1): 179–85.
94. Tramontin D, Cadena-Carrera SE, Assreuy J, Nunes R, Santin JR, Bolzan A, et al. Response surface methodology (RSM) to evaluate both the extraction of triterpenes and sterols from jackfruit seed with supercritical CO2 and the biological activity of the extracts. J Food Sci Technol, 2021; 58(9): 3303–13.
95. Ruiz-Montañez G, Burgos-Hernández A, Calderón-Santoyo M, López-Saiz CM, Velázquez-Contreras CA, Navarro-Ocaña A, et al. Screening antimutagenic and antiproliferative properties of extracts isolated from Jackfruit pulp (Artocarpus heterophyllus Lam). Food Chem [Internet], 2015; 175: 409–16. Available from: http://dx.doi.org/10.1016/j.foodchem.2014.11.122
96. Jagtap UB, Panaskar SN, Bapat VA. Evaluation of antioxidant capacity and phenol content in jackfruit (Artocarpus heterophyllus Lam.) fruit pulp. Plant Foods Hum Nutr, 2010; 65(2): 99–104.
97. Fernando MR, Wickramasinghe SMDN, Thabrew MI, Ariyananda PL, Karunanayake EH. Effect of Artocarpus heterophyllus and Asteracanthus longifolia on glucose tolerance in normal human subjects and in maturity-onset diabetic patients. J Ethnopharmacol, 1991; 31(3): 277–82.
98. Arung ET, Shimizu K, Kondo R. Inhibitory effect of artocarpanone from Artocarpus heterophyllus on melanin biosynthesis. Biol Pharm Bull, 2006; 29(9): 1966–9.
99. Singh A, Painuly N, Kumar V. A SHORT REVIEW ON NUTRITIONAL , PHYTOCHEMICAL AND PHARMACOLOGICAL POTENTIAL ACTIVITY OF JACK FRUIT, 2022; 20(10): 4649–59.
100. Sato M, Fujiwara S, Tsuchiya H, Fujii T, Iinuma M, Tosa H, et al. Flavones with antibacterial activity against cariogenic bacteria. J Ethnopharmacol, 1996; 54(2–3): 171–6.
101. Souza MA, Carvalho FC, Ruas LP, Ricci-Azevedo R, Roque-Barreira MC. The immunomodulatory effect of plant lectins: A review with emphasis on ArtinM properties. Glycoconj J, 2013; 30(7): 641–57.
102. Divina BP DRHJ. Anthelmintic Efficacy of Jackfruit (Artocarpus heterophyllus L.) and Tamarind (Tamarindus indica L.) Leaves Decoction Against Gastrointestinal

Nematodes of Goats. Philipp J Vet Anim Sci, 2012; 38(2): 157–66.

103. Jose Vazhacharickal P, John Mathew J, Kuriakose AC, Abraham B, Mathew RJ, Albin AN, et al. Chemistry and Medicinal Properties of Jackfruit (Artocarpus Heterophyllus): a Review on Current Status of Knowledge. Int J Innov Res Rev [Internet], 2015; 3(2): 83–95. Available from: http://www.cibtech.org/jirr.htm
104. Periyanayagam K, Karthikeyan V. Wound healing activity of the leaves of Artocarpus heterophyllus Lam.(Moraceae) on ex-vivo porcine skin wound healing model. Innovare J Life … [Internet], 2013; 1(1). Available from: https://www.researchgate.net/profile/Venkatachalam-Karthikeyan/publication/304387164_WOUND_HEALING_ACTIVITY_OF_THE_LEAVES_OF_Artocarpus_heterophyllus_Lam_Moraceae_ON_ex-vivo_PORCINE_SKIN_WOUND_HEALING_MODEL/links/576ded0408ae10de6395d6e0/WOUND-HEALING-ACT
105. Okonkwo CC, Agu CV, Njoku OU, Uchenna A, Anaduaka AV, Emeka G, et al. Hypoglycaemic and haematinic properties of ethanol leaf extract of artocarpus heterophyllus in alloxan induced diabetic rats. African J Tradit Complement Altern Med, 2015; 12(2): 144–8.
106. Annisa R, Dewi TJD, Mutiah R, Nurjanah S. Journal of Pharmacy and Chemistry. J Trop Pharm Chem [Internet], 2021; 5(4): 396–405. Available from: https://jtpc.farmasi.unmul.ac.id
107. Onuah C, Anacletus FC, Okoroh PN. THE SYNERGISTIC EFFECT OF ETHANOL LEAF EXTRACT OF ANNONA World Journal of Pharmaceutical Research. World J Pharm Pharm Sci, 2019; 7(19): 52–60.
108. Trindade MB, Lopes JLS, Soares-Costa A, Monteiro-Moreira AC, Moreira RA, Oliva ML V., et al. Structural characterization of novel chitin-binding lectins from the genus Artocarpus and their antifungal activity. Biochim Biophys Acta - Proteins Proteomics, 2006; 1764(1): 146–52.
109. Khan MR, Omoloso AD, Kihara M. Antibacterial activity of Artocarpus heterophyllus. Fitoterapia, 2003; 74(5): 501–5.
110. Khuluq H, Marlina E. Evaluation of antidiarrheal effect of combination of salam leaves (Syzygiumpolyanthum) and jackfruit leaves (artocarpus heterophyllus lam.) infusum in rats induced by castor oil. Pharm Educ, 2021; 21(2): 148–51.
111. Phukan H, Singha LI, Kr Mitra P. Hepato-Protective Effect of Aqueous Extract of Seed, Leaf and Fruit of Jackfruit (Artocarpus Heterophyllus Lam.) Against Ccl 4 Induced

Hepatotoxicity on Swiss Albino Mice. Homen al World J Pharm Res World J Pharm Res SJIF Impact Factor [Internet], 2018; 7(9): 768–79. Available from: www.wjpr.net

112. Gangaraju S, Manjappa B, Subbaiah GK, Kempaiah K, Shashidharamurthy R, Plow JH, et al. Jackfruit (Artocarpus heterophyllus) seed extract exhibits fibrino(geno)lytic activity. Pharmacogn J, 2015; 7(3): 171–7.
113. Sukhdev A. FORMULATION AND EVALUATION OF HERBAL SHAMPOO BY USING JACKFRUIT POWDER FOR ANTIMICROBIAL POTENT, 2024; 11(4): 365–72.
114. Chhotaray S, Priyadarshini B. Nutritional composition and health benefits of jackfruit seed flour: A review. ~ 454 ~ Pharma Innov J [Internet], 2022; 11(10): 454–6. Available from: http://www.plantsjournal.com
115. Nguyen H, Nguyen H, Le Nguyen CT. Phytochemical, nutritional, laxative and hypoglycemic activity evaluation of seeds of jackfruit (Artocarpous heterolphyllus Lam). Res Rev J Bot Sci [Internet], 2016; 5(4): 47–51. Available from: http://www.rroij.com/open-access/phytochemical-nutritional-laxative-and-hypoglycemic-activityevaluation-of-seeds-of-jackfruit-artocarpous-heterolphyllus-lam-.pdf
116. Gupta D, Mann S, Sood A, Gupta RK. Phytochemical, nutritional and antioxidant activity evaluation of seeds of jackfruit (Artocarpous heterolphyllus Lam.). Int J Pharma Bio Sci, 2011; 2(4): 336–45.
117. Amadi JA., Ihemeje A, Afam-Anene OC. Nutrient and Phytochemical Composition of Jackfruit (Artocarpus heterophyllus) Pulp, Seeds and Leaves. Int J Innov Food, Nutr Sustain Agric [Internet], 2018; 6(3): 27–32. Available from: www.seahipaj.org
118. Arora T, Parle A. Jackfruit: a Health Boon. Int J Res Ayurveda Pharm, 2016; 7(3): 59–64.
119. Aggarwal A, Agrawal M, Kumar K, V SPD. Studies on Extraction of Flavonoids from Leaves of Artocarpus heterophyllus, 2023; (2): 2022–6.
120. Alfani NR, Febriyanti R, Amananti W. Indonesian Journal of Chemical Science and Technology (IJCST), 2023; 06(1): 65–75.
121. Ahmmed R, Inam AKMS, Alim MA, Sobhan MM, Haque MA. Extraction and characterization of pectin from jackfruit (Artocarpus heterophyllus Lam) waste. IOSR J Pharm Biol Sci [Internet], 2017; 32(6): 57–66. Available from: www.iosrjournals.org

122. Biworo A, Tanjung E, Iskandar, Khairina, Suhartono E. Antidiabetic and Antioxidant Activity of Jackfruit (Artocarpus Heterophyllus) Extract. J Med Bioeng, 2015; 4(4): 318–23.